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A NEW FORM OF FISHWAY.

By PROFESSOR EDWARD E. PRINCE, LL. D., D. Sc.

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The principle upon which fishways or fish-passes have been constructed in the past has been by arranging the gradient so as to enable fish to ascend from a lower level to a higher level, and thus surmount water-falls, dams, and other obstructions. The greater the height of the obstruction, the steeper, or the longer, the gradient requires to be, and the head of water, or the force and amount of water, permitted to pass through the fishway requires to be varied to suit the different kinds of migratory fish passing up.

EXISTING FISH-WAYS UNSUITABLE FOR ALL FISH.

Each species of fish has its own climbing peculiarities, as it were, and the fish-pass which would suit one kind of fish may not suit another, shad and gaspereaux or alewives being altogether different from salmon or sturgeon. There have been fishways in Canada which proved successful for salmon, but the force of the water killed the weaker fish, such as alewives or smelts. The force of the water knocked these feebler fish against the compartments, and dead fish were often found, proving the utter unsuitability of the fishway for the different kinds of fish attempting to ascend it. Such fishways, as the McDonald fish-pass, endeavored to get over this difficulty of momentum, or force of water, by devices which broke the force and reduced the momentum, but as a rule the introduction of complicated arrangements for this purpose resulted in the accumulation of rubbish, and caused other difficulties, so that the structure was often rendered useless.

My new fishway, which has been tested experimentally in Canada with every evidence of success, adopts the principle of the perpendicular elevator, and if the fish can be induced to enter it, there is no doubt that it will lift them to the top of the obstruction.



THE FISH ELEVATOR IN ACTION

(This plate published by the courtesy of POPULAR MECHANICS MAGAZINE.)

THIS FISH-WAY IS SIMPLE, PORTABLE, AUTOMATIC.

The invention may be described as a fish-trap into which the fish swim and are enclosed, and then lifted up, and dumped over the top of the obstruction. It works automatically by means of a counterpoise or tank which is filled with water by gravitation or by means of a pump, and when full it descends, and in doing so pulls up the fish-trap below containing the fish. Any fish that can be induced to enter a fish-trap can be enclosed and lifted up by this apparatus. It consists of a comparatively light frame work of wood, iron, or other material so as to be portable, and it can be taken to pieces and stored away during the winter. One of the greatest dangers to the ordinary fish-passes is the accumulation of ice in winter about water-falls, dams, etc., which may amount to many tons, and which, during the freezing and thawing periods in winter and spring, often breaks up the fish-pass and carries parts, or it may be the whole of it away. Moreover, freshets in spring damage and destroy many of the fish-passes now in use. In the new fish-elevator the frame work, as I have said, can be taken to pieces, and the structure is not in use during the winter, when no fish are ascending. It is erected just prior to the first runs of fish in spring, and remains in operation only until the last runs of fish in the fall. As a fine-meshed wire net-work covers the whole frame work, rubbish cannot get into it and fill it up. Moreover, its success does not depend upon the varying supply of water, as the filling of the counterpoise can be arranged by taps and valves so that it will operate at regular intervals, whatever the state of the river. There is no necessity for erecting this fish-elevator at the point where the main body of water falls over; but it can be placed to one side, or indeed in any position where the fish can find their way into it, and being raised automatically and dumped out on a level with the height of the obstruction, a sluiceway of greater or lesser length can be devised to convey into the stream above the falls, the fish when dumped out. It can be placed anywhere where fish can be trapped, and there is no necessity for placing it directly against the face of the obstruction for if dumped into a sluice-way the fish can easily swim, as stated, to the pool or stream above the obstruction.

FISH LED IN AND ENTRAPPED.

The entrance to the fish-compartment or fish-trap is wide, and as the whole structure is a light frame work, there is no shadow or darkness about it, and the fish are not deterred on that account. It has been found that many kinds of fish object to entering a dark hole or chamber, but in this case there is no more difficulty in inducing the fish to enter the fish-compartment than in entering any automatic fish-trap along the sea-shore or along the banks of rivers. In order to compel the fish to enter the fish-trap, a wall of wire netting or "a lead" is suspended across the river diagonally which prevents the fish from ascending as far as the foot of the falls or dam and forces them to lead or be guided along the wall of net and enter the fish-trap, as in the case of ordinary commercial fish-traps.

HEIGHT, OPERATION INTERVALS, ETC., CAN BE VARIED.

The height of this structure can be varied for every different condition, and as it works automatically by gravitation, or if necessary, by electric or other power, it will operate as successfully for a low dam, 10 feet high, as for an obstruction, 30 or 40 feet in height; in other words, it is independent of the height of the obstruction. By the arrangement of special valves the counterpoise can be filled at the top of the elevator, and emptied at the bottom of the elevator, at any desired interval of time. In some cases it is desirable that the fish should be lifted up at intervals of not less than two or three hours, in other cases, where great schools of fish are ascending, it should ascend and carry the fish up every 15 or 30 minutes. This can be easily arranged by adjusting the valves.

OTHER FISH EXCLUDED WHEN TRAP ASCENDS.

When the fish-trap has ascended, the vacant space, which it occupied at the bottom, would be a danger to the fish trying to enter during the interval. To shut off the entrance of fish when the fish-compartment is ascending or descending, a special door has been devised which drops down and keeps the fish out, so that they are compelled to wait until the emptied compartment completes its descent. Then, by a special device,

the outer door lifts up, and the fish can enter. There are indeed three doors to this elevator. One is at the back, which opens only when the compartment is at the top of the structure, and the fish find exit by it. The second door is at the front of the compartment, and opens only when the compartment is at the bottom of the elevator, and thus admits the fish, and a third door at the bottom of the elevator which drops down only when the compartment has ascended, and thus prevents fish from entering the space left vacant when the compartment is going up or down.

OBJECTIONS ANSWERED.

The only objections which have been raised to this device are objections which are not really of very great force. Reference may be made to one or two of them. Thus, it is claimed, that the fish-elevator affords no means for the descent of adult fish after spawning, or of the young fish. Young fish can overcome all difficulties, however, in descending streams, and they can be trusted to look after themselves; the main purpose is to enable the parent fish to ascend to the spawning grounds. It has also been objected that the fish might be damaged when being lifted out of the water, and carried up in the fish-trap or wire-compartment; but inasmuch as salmon and other fish damage themselves considerably in jumping precipitous falls, there can be little harm to the fish during the few seconds occupied in being carried up to the top of the elevator. It has been objected, also, that logs and floating debris, and especially an excessive flow of water, might damage the fishway, but as a rule it would not be placed in position until the logs and high water have disappeared, and to avoid danger, it could be safely placed at one side of the obstruction. It need not be placed against the dam or falls, but at 50 or 100 yards away, and longer or shorter horizontal sluices constructed to carry the fish from the top of the elevator to the water above.

ADVANTAGES SUMMARISED.

To summarise the advantages possessed by this elevator fish-pass, which has been protected by patent in the United States, it may be claimed that it is (1) suitable for every kind of fish which ascends rivers. (2) It is not affected by freshets or by

accumulations of ice, as it is dismantled during winter and operates only when the fish run in the spring, summer, and fall. (3) It is automatic and operated by a counterpoise supplied from an elevated tank which fills by gravitation or by hydraulic ram. It may also be operated by electrical or other power. (4) It is adapted to all heights, 10 feet to 100 feet or more. (5) It is capable of being placed in any position in front, or at the side, or some distance below, the obstruction. A longer or shorter horizontal sluiceway enables the fish to pass from the top of the elevator to the pools of water above the dam or falls. No mill or power house is deprived of any water-power. (6) By adjusting the valves, the ascending and descending movements of the fish-trap or fish cage can be arranged at any interval, 15 or 30 minutes, or many hours; thus allowing ample time for a sufficient number of fish to enter the cage. (7) Should more enter the cage than the counterpoise can raise there will be no movement until some of the fish swim out, but the counterpoise is sufficiently heavy to raise the quantity of fish likely to enter during the short intervals allowed. (8) The cost of this device is much smaller than most other fishways in existence. It can be built for a few hundred dollars, being little more than a frame work, lightly but strongly made; whereas, some of the best fishways are costly structures of cement, masonry and timber, and cost many thousands of dollars.